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VISITOR EXPERIENCE IN GOOGLE ART PROJECT AND IN SECOND LIFE-BASED VIRTUAL MUSEUMS: A COMPARATIVE STUDY

Spyros Vosinakis and Yannis Tsakonas

Department of Product & Systems Design Eng, University of the Aegean, Hermoupolis, 841 00, Greece

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Corresponding author: Spyros Vosinakis (spyrosv@aegean.gr)

ABSTRACT

The advances of interactive 3D technologies and the rapid expansion of the Internet have led to the development of a wide variety of solutions for the dissemination of cultural heritage using digital technologies. One such promising approach are Virtual Museums, i.e. digital environments for the presentation of exhibit collections. Currently one may identify two distinct trends in Virtual Museums: exhibition spaces built in Virtual Worlds such as Second Life, and the Google Art Project. A common characteristic of these approaches is that they both aim to replicate the experience of visiting the physical museum space and observing the exhibits. However, looking deeper into several aspects of their interface, one can notice significant differences: modelled vs digitized exhibition space, low-res vs hi-res image presentation, single- vs multi-user visiting experience, static vs interactive exhibits, etc. The aim of our research is to compare the two environments in terms of their effect on the visiting experience and to attempt to identify the critical design features that contribute mostly to the experience. We have setup a study for the comparative evaluation of the two approaches based on the visiting experience of the same exhibition space. We have selected a museum wing already present in the Google Art Project (the 5th floor of the Museum of Modern Art of New York - MoMA) and modelled a replicate of it in OpenSimulator, an open source alternative to Second Life. The analysis of the results indicate that both approaches have been found attractive by the users, but for different reasons, and led to the identification of a number of features that positively affected the experience and have been considered important by the participants.

KEYWORDS: virtual museums, virtual worlds, Second Life, Google Art Project

1. INTRODUCTION

Virtual Museums are a promising new medium for the dissemination of cultural heritage beyond the physical exhibition spaces (Sylaiou et al., 2009). They use state-of-the-art multimedia and interactive 3D technology to create digital spaces for the preservation and exhibition of replicated artifacts of cultural importance. Visitors are usually embodied in the digital space as avatars, may navigate inside the exhibition, observe the artifacts and related information, and in some cases even interact with the content and become more actively engaged with the subject. A large number of virtual museum implementations have been presented in the last two decades with noticeable variations in display technologies, afforded functionality, and interaction styles. Despite the multitude of approaches, there is still a lack of a common model and infrastructure for developing and hosting virtual museums, a fact that significantly prevents them to unleash their full potential.

Currently, there are two noticeable trends in virtual museums, which stem from fundamentally different technical approaches. The first trend is the use of a general-purpose Virtual World platform, in which the museum space and artifacts will be modelled and exposed. A number of museums, galleries and exhibition spaces, real and fictional, have already been created in the Virtual World of Second Life (SL) and became quite popular (Urban et al., 2007). The second trend is the use of panoramic images to present captured aspects of a real museum. The Google Art Project (GAP) is a recent platform for hosting such representations and is already featuring a large number of well-known museum collections (Proctor, 2011). The interface of GAP is enhanced with a navigation mechanism that can switch between adjacent capture spots and produce the feeling of moving inside the exhibition space.

Both aforementioned approaches aim to replicate the experience of a physical visit to the museum and make the user feel immersed in the digital space. There are, however, significant differences between them in terms of modelling the environment, visualizing the exhibits, interaction affordances, sharing of the experience, etc. It would be interesting to examine and compare the two approaches in order to gain a better understanding about the effect of the various design aspects to the overall experience, and to identify possible paradigms and guidelines for future designs.

In this paper we present a first step towards this goal. We have prepared a comparative evaluation of the two approaches focusing mostly on the experience of visitors. In our study we used a representation of the same exhibition place in both platforms. We chose an existing museum floor presented in GAP and replicated the same environment and exhibits in a SL-based Virtual World. We asked users to visit both exhibition spaces and measured various aspects of their experience. The analysis of the results indicate that both approaches have been found attractive by the users, but for different reasons, and led to the identification of a number of features that positively affected the experience and have been considered important by the participants.

2. VIRTUAL MUSEUM PLATFORMS

Virtual Museums aim to overcome the limitations of the physical space and to provide a vivid experience to remote visitors (Schweibenz, 1998). In physical museums the emphasis is usually placed in communicating the visual qualities of the artifact collection being presented, such as form, size and texture. Modern computer graphics technology can represent images and 3D geometric objects in high detail and, therefore, it is easy to create a digital collection that replicates these qualities (Tsichritzis & Gibbs, 1991). Utilizing this capability, a number of applications or web sites feature digital collections of cultural objects that are presented in a unified space as a digital counterpart of a physical museum. Some approaches aim to replicate the physical visit and, are thus targeted to people not being able to see the actual exhibition. Others aim to complement a visit with additional information, e.g. to help visitors plan their route before the visit, or to present further content related to the exhibits they just visited. Finally, there are virtual museums that do not strictly replicate the structure and contents of a single museum, but include collections of various artifacts presented in novel ways (Lepouras et al., 2004).

A large number of Virtual Museums provide a 2D user interface. They are mostly Web-based and their collections are organized following the traditional GUI/Web metaphors: using pages, subpages and hyperlinks between them. The exhibits may be presented in various ways, as still images, animations or 3D objects, and may also be accompanied with related media, but the common characteristic is that they are not part of a unified 3D space. The user experience is, thus, similar to browsing an informational site. It limited to page viewing and sequential browsing of the contents.

Other Virtual Museums are based on 3D interaction technologies (Lepouras & Vassilakis, 2005). They use a 3D representation of the museums space, and the artifacts are embedded as parts of it. Users can navigate and browse the objects using physical and intuitive metaphors: walking inside the space from a first or third person view and observing the

3D objects. This approach provides a more realistic visiting experience, as it aims to replicate the experience of a physical museum visit. The individual artifacts are not isolated, as in the case of 2D interfaces, but exhibited in a common space, in which the background space and the relative placement of the objects takes active part in the presentation. Finally, well designed and usable 3D applications may lead to a more entertaining experiences compared to a web interface (Sylaiou et al., 2010).

Virtual Museums can offer new forms of presentation and interaction beyond passive viewing of the exhibits. The artifact presentation can be augmented with related information, stories and hyperlinks presented using text, narration, animation, or video. Furthermore, the interactivity of the experience can be enhanced by letting users interact with the exhibits, switch between various representations, e.g. historical evolution, use them and learn about their functionality, play mini-games, etc. Further enhancements may include virtual guides that discuss with users and present the space (Karakatsiotis et al., 2008), and adaptive, personalized exhibition spaces (Bonis et al., 2009).

A wide variety of implementation technologies and approaches have been employed for virtual museums in the last decades. As mentioned before, some applications are based on 2D interfaces and others on 3D. Regarding the presentation of the space and the exhibits some applications use panoramic photographs to present the interior of a physical space or the external form of objects (Chen, 1995), and others are based on 3D geometry models created using digitization and modelling techniques. There are virtual museums that are single-user, in which the user is isolated in the museum space, and other, multi-user approaches, where multiple visitors coexist as avatars and can communicate with each other and participate in shared activities (Vosinakis & Xenakis, 2011). As far as the execution platform is concerned there are standalone, browser-based, or even mobile approaches. There are also museums that have been built inside an existing platform, such as a multi-user game or a Virtual World. Besides typical desktop applications, there are immersive museums that use specialized hardware to provide a vivid virtual reality experience (Carrozzino & Bergamasco, 2010; Roussou, 2001), and augmented reality approaches, in which the virtual elements are superimposed on top of the physical museum environment (Damala et al., 2008).

The existence of multiple approaches based on various technologies is certainly a drawback for the wider usage of these systems. Systems with immersive VR or AR hardware are too expensive to build and not accessible by typical home computer users, standalone and single-user systems cannot offer collaborative and social experiences, and multi-user environments implemented in different platforms cannot take advantage of a single user base and require from visitors to create and maintain multiple accounts. Based on these observations, there is a need for a common underlying platform for presenting museum exhibits and archaeological sites, which can support most of the functionality and features found in existing implementations. Museums hosted in generic Virtual Worlds such as Second Life and the Google Art Project are two possible such platforms.

2.1. Second Life-based Museums

Second Life is a multi-user persistent 3D Virtual World that became very popular during the last decade. It allows users to participate and collaborate in a shared environment built and maintained by the users themselves. It offers the freedom to create and formulate spaces, to program the interactivity of objects using a scripting language, and to customize the user interface. These features attracted a lot of attention and quickly led to the formation of a very large user community that created various types of applications and constantly expanded the constructed area of the Virtual World. Second Life is still the most popular general-purpose Virtual World, but the fact that land ownership and in-world building require paid subscriptions, has led its citizens to seek other solutions. The open-source alternative OpenSimulator, a Virtual World platform that replicates the functionality of Second Life, has gained a lot of popularity recently.

A variety of places for art and cultural heritage, including virtual museums, have been created in Second Life. Their main aim was to let visitors observe and interact with cultural artifacts and get rich information about them. Most of these places are still operational, despite Second Life's recent decline in popularity, while new ones are emerging in alternative platforms, such as OpenSimulator (Hernández Ibáñez & Barneche Naya, 2012; Sequeira & Morgado, 2013). In some approaches the emphasis is placed in the exhibits themselves, and they are presented in simplified spaces to let users focus their attention on the artifacts. In others, the surrounding space is also a subject of interest and is included in the virtual representation. Some virtual museums have permanent exhibitions, while others renew their contents, sometimes with the participation and suggestion of visitors (Urban et al., 2007). The accompanying information varies from simple text notes to multimedia information such as images, videos and hyperlinks.

2.2. *Google Art Project*

The GAP is a recent approach by Google for disseminating art and cultural heritage. Its goal is to present the collections of museums and institutions to a wider audience through a simple and usable web interface. Its functionality is twofold: users can examine specific artifacts in high detail views, and they can also navigate in the interior of selected museum wings and see the artwork placed in its physical context. Another interesting feature is that users can pick specific pieces of art from various collections in order to create and publish their own personalized collections. The project has launched in 2011 with 17 participating museums from Europe and the US. Its popularity made it quickly expand its contents, and nowadays it includes 670 collections from all over the world, out of which 267 allow exploration of the interior space.

A distinctive characteristic of GAP is the detailed visual presentation of the artwork. The collection items have been photographed in very high detail, sometimes in gigapixel resolution. Users can zoom in or out, move the focus point in two dimensions, and get focused views on specific parts of the artifacts. Actually, they can see details on the surface of objects, such as dots of paint and cracks, which they would have missed with naked eye. According to Davis (2011) the artifact presentation of GAP is "hyperreal" in the sense that the observers in full zoom have a more detailed view than the creator himself might had. Proctor (2011) also argues that GAP not just imitates, but complements a museum visit by offering such high-resolution views. A downside of this approach is that the presentation and the interface are purely 2D. This might be enough in the case of paintings, and for that reason the initial collections of GAP consisted mostly of paintings, but as far as sculptures, tools and other geometric objects are concerned, the observer is restricted to a single-sided view of the object.

The navigation in the museum interiors of GAP is based on Google Street View technology. Visitors can have virtual walkthroughs inside famous museums, navigate around and observe the exhibits placed in their physical space. The interior space has been modelled based on multiple panoramic photographs using the same technique and user interface as in Google Street View. As a result, the navigation experience is also similar: the user does not freely move around, but switches between predefined spots. In each of these spots he/she can look around or zoom on the exhibits. If users click on the featured exhibits, the interface switches to the detailed, photographic presentation introduced before, where they can observe more details.

3. STUDY DESIGN

Both approaches, SL and GAP, are prominent platforms for a unified representation space for museums and cultural heritage collections, stemming however from very different technological origins. In both approaches designers aim to replicate the user experience of visiting a physical museum space and observing the exhibits and, thus, the emphasis is put in the 'natural' exploration of the space and the highlighting of the collection. Nevertheless, one can identify fundamental differences in the content production, place representation and the user interface in these approaches. In Virtual Worlds such as SL the exhibition place has to be modelled in 3D as a collection of geometrical objects that are appropriately scaled and positioned in the space. Modelling in 3D is a slow and painstaking approach and may introduce errors, even with the use of digitization techniques with specialized hardware and software. On the other hand, the interior museum wings presented in GAP have been modelled as series of photographs that generate panoramic views in predefined spots. The process is significantly faster and the visualization has photographic quality, as expected. Furthermore, the artifact representations in real-time 3D environments such as SL cannot have as high resolution as the gigabit pictures of GAP, due to limitations of the rendering technology. On the other hand, visiting a museum in GAP is certainly a single-user and non-interactive experience. In SL-based museums, designers have the freedom to explore and utilize social and interactive aspects of the experience, such as meetings, presentations, mini-games, virtual guides, etc. Finally, the navigation mechanism of SL is smoother and less restrictive compared to the viewpoint switching approach of GAP.

Our study aimed to discover the impact of the aforementioned advantages and drawbacks in the overall experience. We compared the two environments in terms of their effect on the visiting experience and attempted to identify critical design features that contribute mostly to the experience. The main scenario was to let users experience a 'virtual visit' of the same museum wing presented in both platforms and have them evaluate various aspects of their experience.

To prepare the scenario, we constructed a replicate virtual world of a museum already existing in GAP. We selected the 5th floor of the Museum of Modern Art in New York (MoMA), which hosts fifteen famous paintings, and created respective 3D models of the space and the environment. We used the OpenSimulator as a platform for SL-based museums, because it is allows content creation and image uploading for free and it has the same function-

ality as SL; the software on the client side is the same. The model of the environment has been built in physical size based on the interior representation and the respective top-down view of the environment in GAP. The paintings were also created in physical dimensions and placed in appropriate positions on the walls of the virtual museum. Each exhibit of the SL-based museum presented an accompanying information card when clicked and had links to Web pages for further information about it. Figure 1 displays a screenshot of the virtual museum in both environments and an information card presented in the SL-based museum.

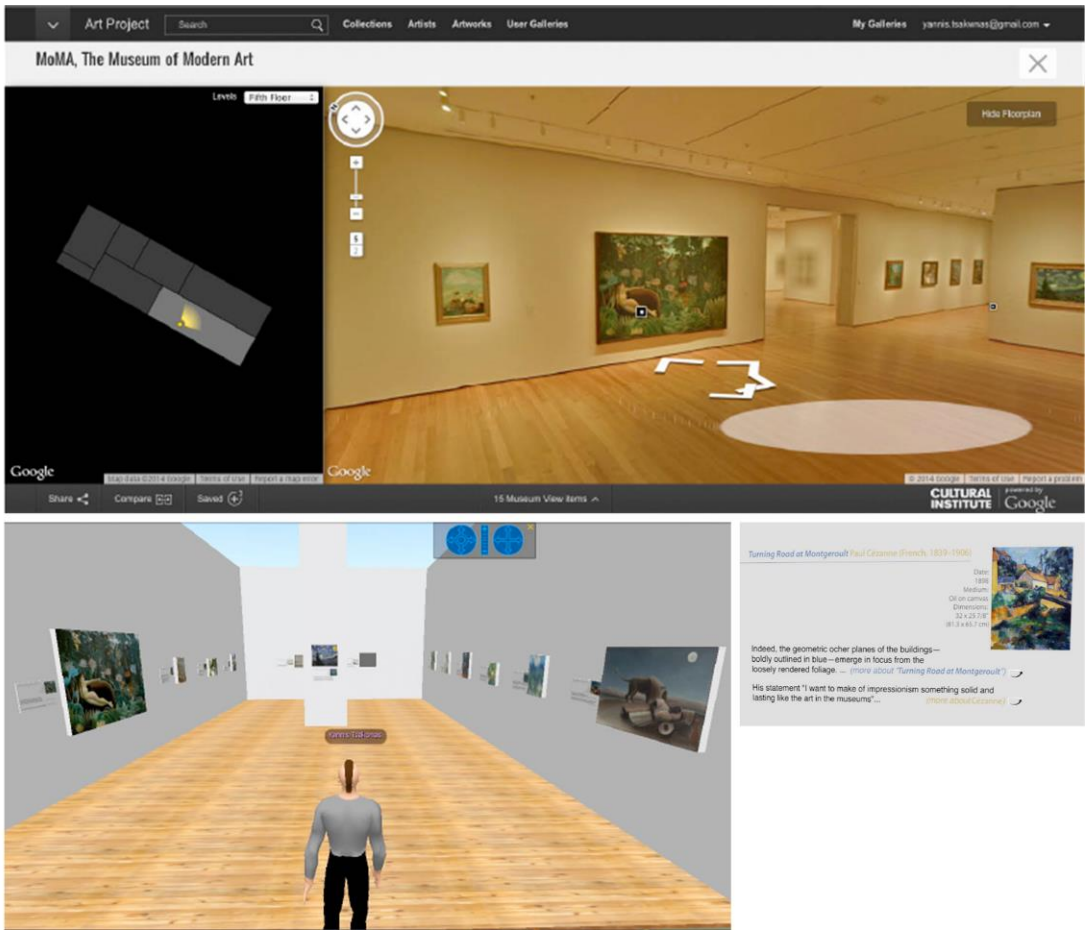


Figure 1. Screenshot of the museum environment in Google Art Project (top) and in OpenSimulator including a typical information card (bottom).

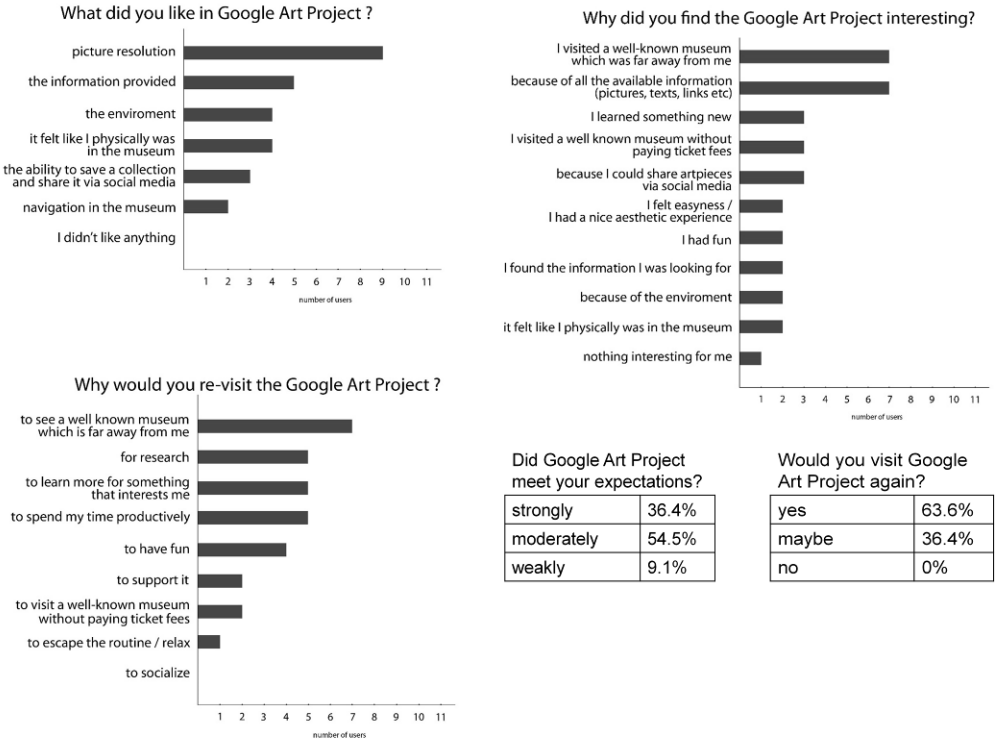
Eleven users (6 male and 5 female) participated in the scenario. All of them were undergraduate students of the Department of Product & Systems Design Engineering, University of the Aegean and, as such, possibly interested in and familiar with works of art. Given the small number of users, we used a within subjects design. The users were split in two groups, each of which visited both museums but with reversed order (1st group: SL-based and then GAP, 2nd group: GAP and then SL-based) to balance out the carryover effects. Initially, the two platforms have been presented to the users. Then, they were asked to explore the place, visit all exhibits of the collection and get further information of at least three of them. In the SL-based museum the members of the group could see each other as avatars and communicate with them. The data collection process was based on a mixture of methods. We used questionnaires before and after the experience, observation of their reactions during the experience, and an open discussion afterwards.

4. RESULTS

In the initial questionnaire we asked users about their attitude towards physical and virtual museums. As expected, the majority of users were regular museum visitors. In a question about the frequency of their museum visits the most popular answers were "whenever I see something that interests me" (7 users), "whenever I travel" (6 users) and "whenever I get a chance" (3 users). No user answered "rarely or never". Regarding the reasons for visiting a virtual museum, the most popular answers were "to see the collection of a well-known museum that I cannot physically visit", "to find out more about a subject I

am interested in" and "to spend my free time productively".

Regarding their experience with the two platforms, it seems that users found both of them interesting, but for different reasons. The questionnaire results are summarized in figures 2 (GAP) and 3 (SL-based).



Did Google Art Project meet your expectations?

strongly	36.4%
moderately	54.5%
weakly	9.1%

Would you visit Google Art Project again?

yes	63.6%
maybe	36.4%
no	0%

Figure 2. Questionnaire results for Google Art Project.

We can see that the majority of users were impressed by the high resolution of the artworks in GAP, and they also liked the information provided and the environment. Nevertheless, less than half of the users responded that they "felt like physically being in the museum", so the initial aim of replicating the experience of a physical visit did not seem to work fully. It is also noticeable that the main aspects of their experience with GAP that users found more interesting were that they managed to visit a well-known museum from distance, and that it offered plenty of related information regarding the exhibits. 36.4% of users replied that GAP met their expectations a lot and 54.4% moderately. Also, a 63.6% of users replied that they would visit the platform again, and the main reason for doing so is to visit famous museums and collections.

In the SL-based approach users seemed to be more fascinated with the affordances of the environment than with the collection itself. This was somehow expected as most of them had not experienced multi-user 3D environments that way before. Users liked the navigation mechanism, the ability to communicate with others and to interact with the environment, and the appearance and motion of avatars. The interesting aspects of their experience, based on their replies, were that they learned something new (referring to the platform itself), they had fun and could communicate with other users. However, only one person replied that it felt like being in the museum. Furthermore, only 27.3% of users replied that the platform met their expectations a lot, and 63.6% moderately. This relatively low score may have been influenced by the fact that the rendering quality of the environment was not as high as in modern computer games. Unexpectedly enough, in the question whether they would visit the platform again 72.7% of the users were positive. The main reasons were to further explore its possibilities, to spend time productively and to have fun.

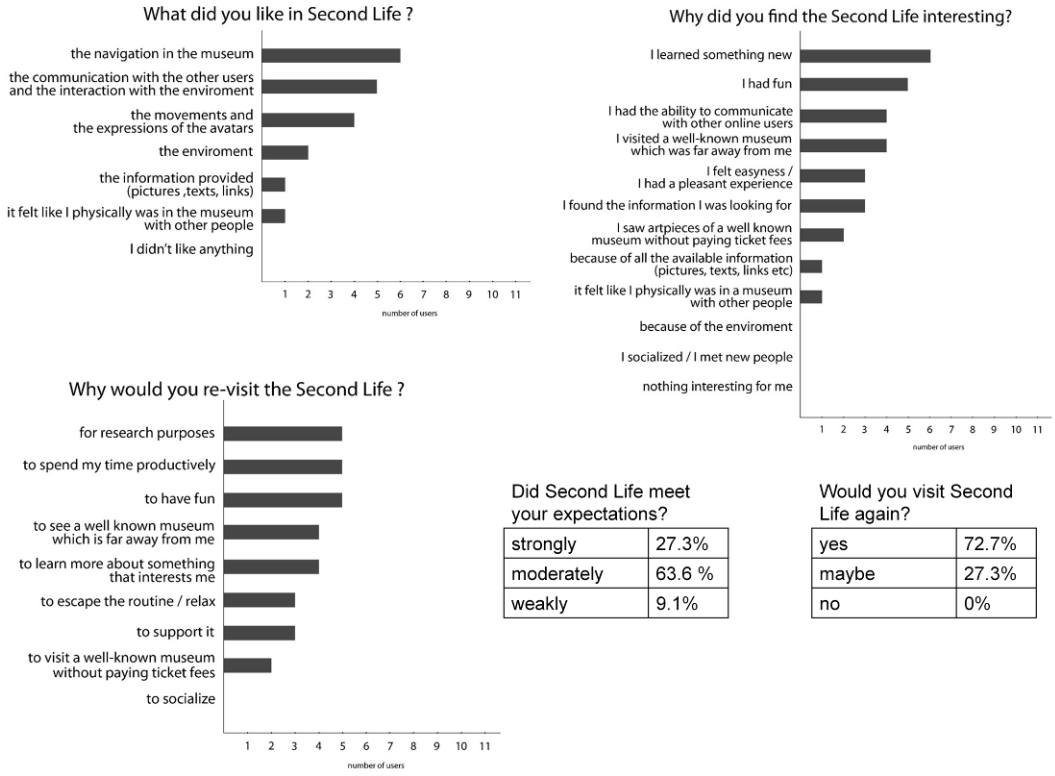


Figure 3. Questionnaire results for Second Life-based museum.

5. DISCUSSION AND CONCLUSIONS

Based on the user observation, their replies in the questionnaires, and the discussion that followed, it seems that users enjoyed the environment and interface of the SL-based museum. They liked that their self was represented as an avatar inside the space, that they could freely and smoothly control its movements and inspect the environment from any point of view. Furthermore, they found the social aspects also important. They were pleased with the fact that they could meet their peers inside the space, observe their motion and actions, and communicate with them in real-time. Overall, the users found the experience more playful compared to GAP. We noticed that they spent more time moving around, discussing and exploring the capabilities of the environment than visiting the additional information pages of the exhibits.

The user interaction with SL was, however, not without obstacles. It has been noted that users felt quite restricted inside the museum space and in some cases had difficulties to steer the avatar's motion. It seems that a virtual representation of a physical interior space in the same scale can lead to navigational problems and make the user feel confined in it. Also, positioning the camera in a third person view can be problematic if the walls are too close to each other. Similar difficulties have been documented in other studies (e.g. Minocha & Reeves, 2010). These obstacles may be tackled if the building design favors functionality over realism, e.g. to use larger or alternative space representations. A challenging design issue for virtual museums would then be to propose and create suitable representations that offer enough free space to facilitate user navigation and also retain the look and aesthetics of the original place.

The main advantage of GAP seems to be the high-quality representation of the space and exhibits. Users enjoyed the display quality and zooming capabilities of the exhibit presentations, and they were also happy that they could have a detailed look of the actual interior of the museum and navigate in it. GAP is found to be more suitable for studying the exhibits and learning about them. The Web interface and the related 2D browsing tools for observing the exhibits provide undistorted and detailed visualizations of the works of art and the user finds himself in an appropriate environment for learning and researching about a subject. On the other hand, the browsing of the exhibits in the SL-based interface required from the users to move their avatars to an appropriate position and to use the zooming tools in order to magnify the painting on the screen, which needed additional skills and effort, and, still, the quality would not be the same. As expected, users

spent more time observing and studying the exhibits in GAP compared to SL.

A further advantage of GAP and related approaches from the designer's point of view is the significantly smaller time and effort needed to create the space and exhibit presentations compared to a 3D environment. There is no need for modelling, texturing, scene arrangement, lighting, optimization, etc. as in the case of SL-based approaches.

A notable downside of GAP is its inability to provide holistic views of 3D artifacts. The museum wing used in our study intentionally did not include any sculptures or other 3D objects, but if one visits online exhibitions with such content, one can quickly notice this inability. The browsing interface is 2D and presents only a single side of each exhibit. In the interior navigation mode the situation is not improved: 3D exhibits can be observed only from specific points of view depending on the location of the nearby spots that have been used for creating the panoramic views.

Given the positive aspects of both platforms, there is a need for a common environment for interconnected museums and virtual heritage applications that combines these affordances. Such a space could host replications of popular cultural spaces for remote visitors and also alternative spaces that unify custom collections with common characteristics. Ideally, the strengths of games and 3D environments and high-detail 2D representations should be combined in a single environment that would afford free navigation, a playful immersive environment, shared multi-user experience, high-quality representation of artifacts and usable tools for zooming-in and examining. Such an environment should also be available in multiple platforms, e.g. standalone and mobile devices.

A limitation of the current study is that it has been based on a relatively small number of users, who were mostly young adults interested in arts and design. There is clearly a need for further, large scale comparative studies of various interfaces and solutions, which would probably lead to appropriate guidelines and design patterns for future virtual museum experiences.

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